

REMARKS/ARGUMENTS

Reexamination of the captioned application is respectfully requested.

A. SUMMARY OF THIS AMENDMENT

By the current amendment, Applicants basically:

1. Amend claims 1, 2, 4, 5, 6, 8, 9, 12, and 16.
2. Cancel claim 15 without prejudice or disclaimer.
3. Add new claims 18 – 21.
4. Respectfully requests a telephonic interview.
5. Respectfully traverse all prior art rejections.

B. PATENTABILITY OF THE CLAIMS

Claims 1, 2, 4, 7-9 and 13-17 stand rejected under 35 USC 103(a) as being unpatentable over the admitted state of the prior art in view of U.S. Patent 6,229,211 to Kawanoue et al. Claims 3 and 10 stand rejected under 35 USC 103(a) as being unpatentable over the admitted state of the prior art in view of U.S. Patent 6,229,211 to Kawanoue et al as applied to claims 1, 2, 4, 7-9 and 13-17 and further in view of U.S. Patent 6,284,649 to Miyamoto. Claims 5-6 and 11-12 stand rejected under 35 USC 103(a) as being unpatentable over the admitted state of the prior art in view of U.S. Patent 6,229,211 to Kawanoue et al as applied to claims 1, 2, 4, 7-9 and 13-17, and further in view of the Wang et al Electroless article. All prior art rejections are respectfully traversed for at least the following reasons.

The use of a conventional displacement plating (electroless plating) process for plating a via hole in a device presents a problem as the device size becomes smaller and smaller, e.g., when the line width of a wire becomes as narrow as 100 nm or less, for instance. The problem is that a void may result in the plating.

The inventors have found that a native oxide film formed on the barrier layer is a cause of the problem, and that such void can be avoided by controlling the thickness of the oxide film, which is done by controlling the N/Ta ratio of the barrier layer.

The Office Action alleges that Kawanoue teaches a barrier metal film that can be used when forming embedded multilevel interconnection, where a copper layer is applied over the barrier film, and ratio of N/Ta of the barrier film can be 0.87, for example (page 5, lines 10-16 of the Office Action).

Kawanoue, however, discloses a damascene process *using electroplating*. In Kawanoue barrier metal film layer 20 of TaN and Cu film (seed layer needed for electroplating) 17₁ are successively formed using a sputter method before the Cu electroplating step (column 8, line 51 through column 9, line 7). That is, in Kawanoue, the barrier metal film layer 20 of TaN is covered by the Cu film (seed layer) 17₁ without exposing the barrier metal film layer 20 to atmosphere including O₂. Therefore, with Kawanoue's barrier metal film layer 20 of TaN being covered by the Cu film, Kawanoue does not even encounter the problem regarding native oxide formed on the barrier metal film layer 20.

Applicants, on the other hand, use displacement plating (electroless plating) instead of electroplating. As described in amended Claim 1, the displacement plating requires the acts of:

- (3) exposing the barrier metal film to atmosphere,
- (4) removing an oxide film formed on the barrier metal film during act (3), and
- (5) immersing the barrier metal film in a plating liquid..., thereby forming an electroless copper plating film on the barrier metal film.

Therefore, in an electroless plating process, Applicants' acts (3) and (4) prevent the occurrence of a void.

In view of the nature of the Kawanoue process, in Kawanoue native oxide is not formed on the barrier metal film layer 20 and there is no teaching or suggestion about relation between N/Ta ratio and the thickness of the native oxide formed on it, or about controlling the thickness of the native oxide by controlling the N/Ta ratio of the barrier layer.

C. REQUEST FOR TELEPHONIC INTERVIEW

The undersigned is requesting a telephonic interview for the purposes of explaining patentability of the pending claims. If the interview has not already been scheduled and/or conducted by the time of consideration of this Amendment, the examiner is requested to contact the undersigned to arrange for an interview.

D. MISCELLANEOUS

In view of the foregoing and other considerations, all claims are deemed in condition for allowance. A formal indication of allowability is earnestly solicited.

The Commissioner is authorized to charge the undersigned's deposit account #14-1140 in whatever amount is necessary for entry of these papers and the continued pendency of the captioned application.

Should the Examiner feel that an interview with the undersigned would facilitate allowance of this application, the Examiner is encouraged to contact the undersigned.

SHINGUBARA et al.
Serial No. 10/809,681

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Art Unit: 1762

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: /H. Warren Burnam, Jr./
H. Warren Burnam, Jr.
Reg. No. 29,366

HWB:lsh
901 North Glebe Road, 11th Floor
Arlington, VA 22203-1808
Telephone: (703) 816-4000
Facsimile: (703) 816-4100